7. TOTAL PRODUCT CALCULATIONS USING WINDOW

7.1. Overview

WINDOW determines the total product U-factor according to *NFRC 100* and *ISO 15099* by calculating an area-weighted average of the U-factors of the product components and accounting for product height:

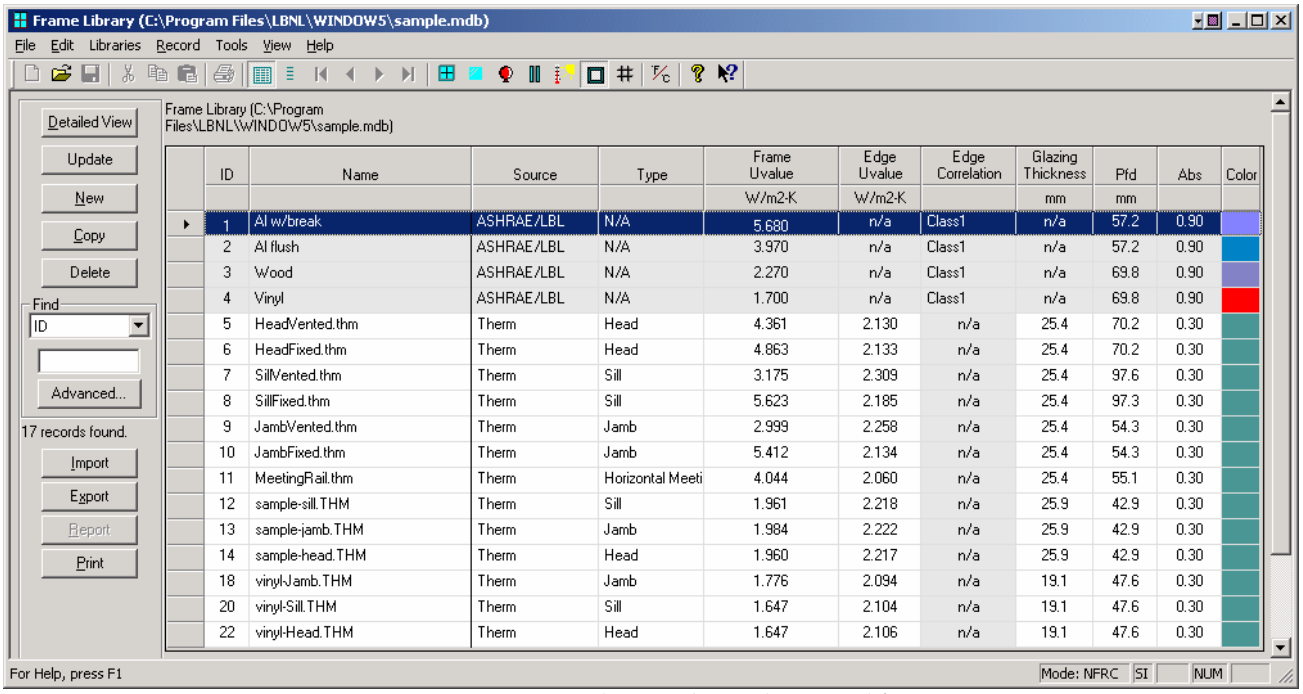
- Frame and edge values for each cross section (frames and dividers) calculated in THERM: The U-factors are area-weighted based on the projected area on a plane parallel to the glass (the **Projected in the Glass Plane** choice in the THERM U-factors dialog box), not the total surface area of the frame and edge.
- Center-of-glazing values from WINDOW

WINDOW calculates the total product area-weighted solar heat gain coefficient (SHGC) and visible transmittance (VT) according to the *NFRC 200* procedures and the total product Condensation Resistance (CR) according to the *NFRC 500* procedures.

7.2 Frame and Edge U-factors from THERM

As discussed in Section 6.6.7, "Importing Results into WINDOW", THERM files are imported into the WINDOW Frame and Divider Libraries in order to calculate the whole product values in WINDOW.

When the THERM files are imported into the WINDOW **Frame** and **Divider Libraries**, they can be used in whole product calculations. The **Source** field in the **Frame Library** indicates whether the files were imported from THERM, as shown in the following figure.



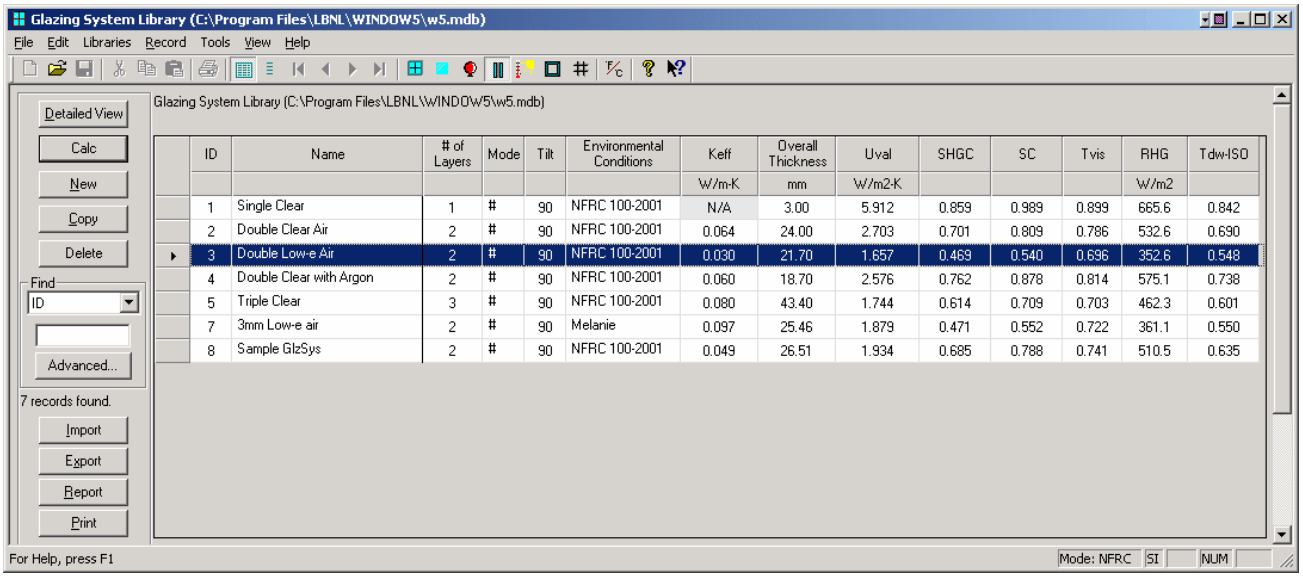
ID	Name	Source	Type	Frame Uvalue	Edge Uvalue	Edge Correlation	Glazing Thickness	Pfd	Abs	Color
				W/m2-K	W/m2-K		mm	mm		
1	Al w/break	ASHRAE/LBL	N/A	5.680	n/a	Class1	n/a	57.2	0.90	
2	Al flush	ASHRAE/LBL	N/A	3.970	n/a	Class1	n/a	57.2	0.90	
3	Wood	ASHRAE/LBL	N/A	2.270	n/a	Class1	n/a	69.8	0.90	
4	Vinyl	ASHRAE/LBL	N/A	1.700	n/a	Class1	n/a	69.8	0.90	
5	HeadVented.thm	Therm	Head	4.361	2.130	n/a	25.4	70.2	0.30	
6	HeadFixed.thm	Therm	Head	4.863	2.133	n/a	25.4	70.2	0.30	
7	SillVented.thm	Therm	Sill	3.175	2.309	n/a	25.4	97.6	0.30	
8	SillFixed.thm	Therm	Sill	5.623	2.185	n/a	25.4	97.3	0.30	
9	JambVented.thm	Therm	Jamb	2.999	2.258	n/a	25.4	54.3	0.30	
10	JambFixed.thm	Therm	Jamb	5.412	2.134	n/a	25.4	54.3	0.30	
11	MeetingRail.thm	Therm	Horizontal Meeti	4.044	2.060	n/a	25.4	55.1	0.30	
12	sample-sill.THM	Therm	Sill	1.961	2.218	n/a	25.9	42.9	0.30	
13	sample-jamb.THM	Therm	Jamb	1.984	2.222	n/a	25.9	42.9	0.30	
14	sample-head.THM	Therm	Head	1.960	2.217	n/a	25.9	42.9	0.30	
18	vinyl-Jamb.THM	Therm	Jamb	1.776	2.094	n/a	19.1	47.6	0.30	
20	vinyl-Sill.THM	Therm	Sill	1.647	2.104	n/a	19.1	47.6	0.30	
22	vinyl-Head.THM	Therm	Head	1.647	2.106	n/a	19.1	47.6	0.30	

Figure 7-1. WINDOW Frame Library with records imported from THERM.

7.3 Center-of-Glazing U-factors from WINDOW

The *WINDOW User's Manual* contains detailed information about calculating the center-of-glazing U-factors.

For an NFRC simulation, create glazing systems that represent all the glazing types to be modeled from the glass matrix provided by the manufacturer. In WINDOW, access the **Glazing System Library List View** either from the **Libraries/Glazing System** menu, by clicking on the **Glazing System Library** toolbar button, or by pressing **F5**.

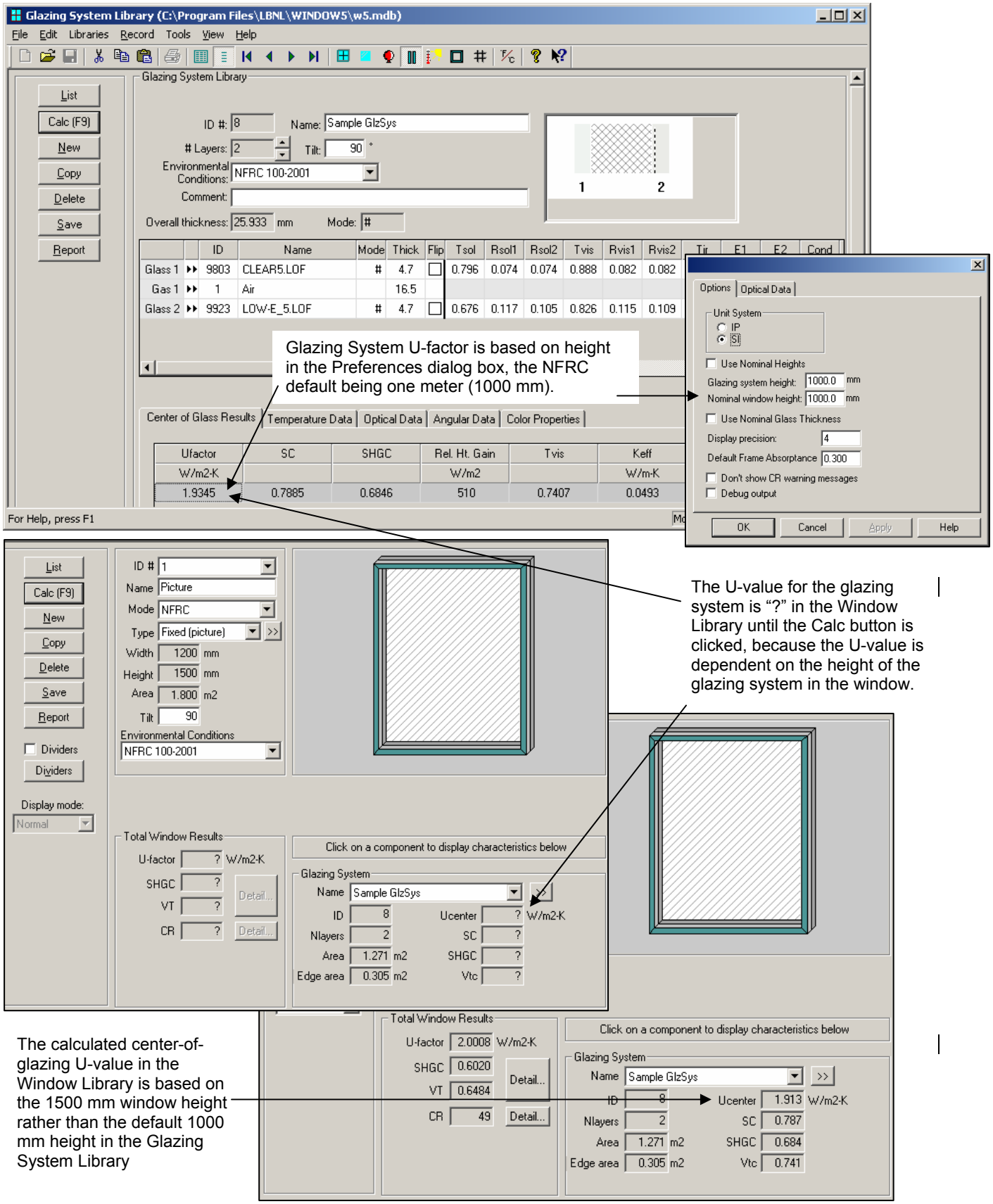


ID	Name	# of Layers	Mode	Tilt	Environmental Conditions	Keff	Overall Thickness	Uval	SHGC	SC	Tvis	RHG	Tdw-ISO
						W/m-K	mm	W/m2-K				W/m2	
1	Single Clear	1	#	90	NFRC 100-2001	N/A	3.00	5.912	0.859	0.989	0.899	665.6	0.842
2	Double Clear Air	2	#	90	NFRC 100-2001	0.064	24.00	2.703	0.701	0.809	0.786	532.6	0.690
3	Double Low-e Air	2	#	90	NFRC 100-2001	0.030	21.70	1.657	0.469	0.540	0.696	352.6	0.548
4	Double Clear with Argon	2	#	90	NFRC 100-2001	0.060	18.70	2.576	0.762	0.878	0.814	575.1	0.738
5	Triple Clear	3	#	90	NFRC 100-2001	0.080	43.40	1.744	0.614	0.709	0.703	462.3	0.601
7	3mm Low-e air	2	#	90	Melanie	0.097	25.46	1.879	0.471	0.552	0.722	361.1	0.550
8	Sample GlzSys	2	#	90	NFRC 100-2001	0.049	26.51	1.934	0.685	0.788	0.741	510.5	0.635

Figure 7-2. WINDOW Glazing System Library.

For NFRC certified simulations, use the currently approved International Glazing Database (IGDB) spectral data, imported into the WINDOW **Glass Library**. Glazing Systems that use approved spectral data will have a "#" in the **Mode** field, as shown in the figure above.

The U-factors shown in the **Glazing System Library** are based on a one meter default height. When these glazing systems are used in whole products, in the **Window Library**, the center-of-glazing U-factors will be recalculated based on the actual product height specified in the **Window Library**. Therefore, the U-factors in the **Glazing System** and **Window Libraries** will probably be slightly different.



Glazing System U-factor is based on height in the Preferences dialog box, the NFRC default being one meter (1000 mm).

The U-value for the glazing system is "?" in the Window Library until the Calc button is clicked, because the U-value is dependent on the height of the glazing system in the window.

The calculated center-of-glazing U-value in the Window Library is based on the 1500 mm window height rather than the default 1000 mm height in the Glazing System Library

Figure 7-3. WINDOW Glazing System Library.

7.4 Overall Product U-factor, SHGC, VT, and CR Calculations

When the THERM results have been imported into the WINDOW **Frame** and **Divider Libraries**, and the needed glazing systems have been defined in the **Glazing System Library** (also needed for the THERM simulations), the whole product values for U-factor, SHGC, VT and CR can be calculated in the Window Library. Calculating these values is explained briefly below and in more detail in the *WINDOW User Manual*.

In the **Window Library Detail View**, set the appropriate values on the left-hand side of the screen, which depend on the type of fenestration product. The **Mode** field should be set to "NFRC", and the **Type** field should be set to the appropriate choice for the fenestration product being modeled. The complete list of choices can be viewed by clicking on the double arrow next to the **Type** pulldown list. The choices with the **Size** field set to "NFRC" are the official NFRC sizes. The **Environmental Conditions** field should be set to "NFRC 100-2001".

On the right-hand side of the screen, for each cross section component, select the appropriate records from the **Frame** and **Divider** libraries. When the frame cross sections and the glazing systems are specified, click on the **Calc** button and WINDOW will calculate the total product U-factor, SHGC, VT and CR, shown in the lower left corner of the main screen. In addition, for obtaining NFRC rating values, the program calculates the $SHGC_0$, $SHGC_1$, VT_0 and VT_1, discussed in detail in the following section.

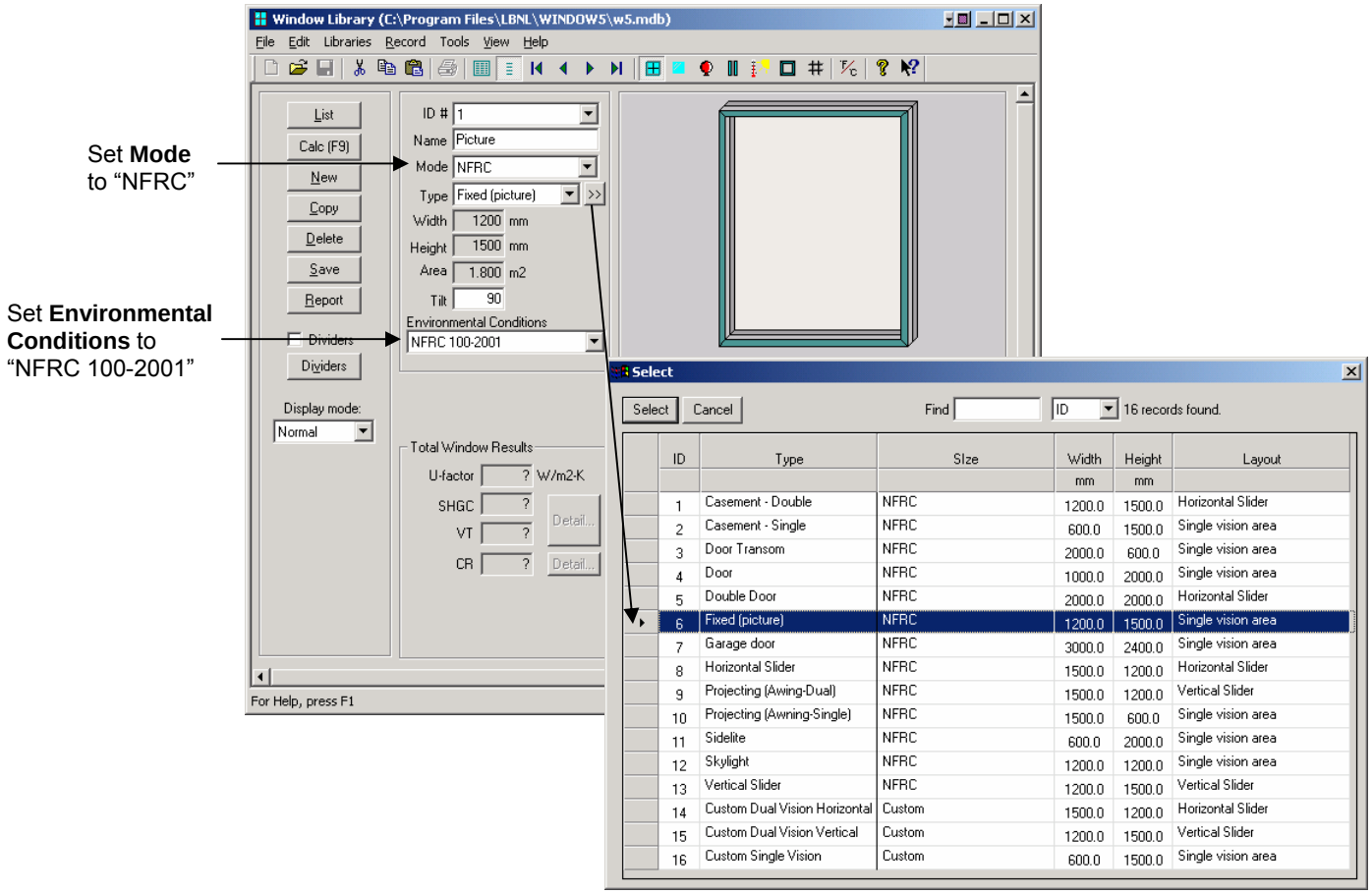
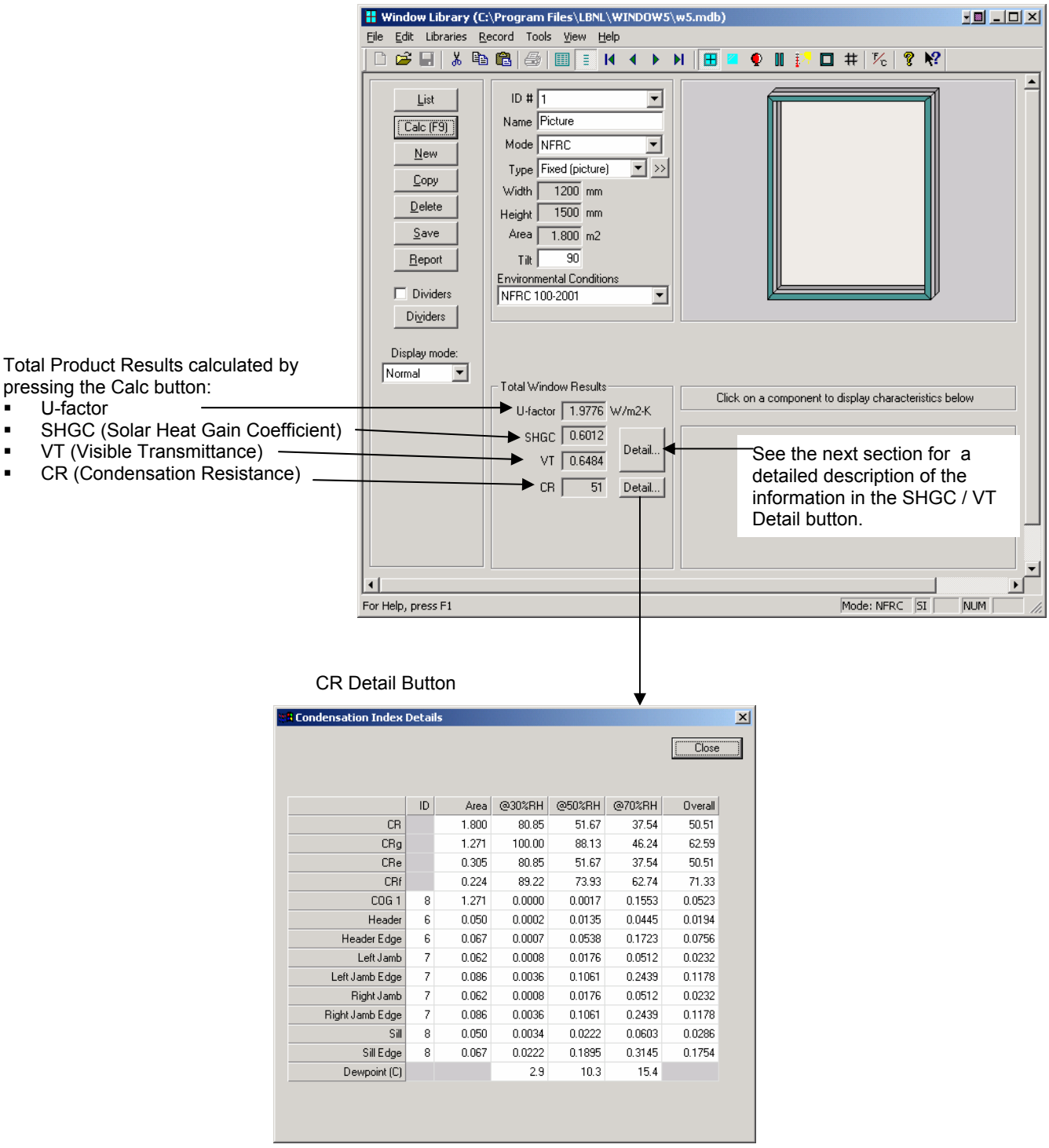


Figure 7-4. Window Library Detail View where the whole product is defined.

Once the values have been calculated, the results are displayed in the **Total Window Results section**, as shown below. The **Detail** button next to the **SHGC** and **VT** results can be used to view the $SHGC_0$, $SHGC_1$, VT_0 and VT_1 values, and the **Detail** button next to the **CR** result is used to view the intermediate values used to determine the overall CR result.



	ID	Area	@30%RH	@50%RH	@70%RH	Overall
CR		1.800	80.85	51.67	37.54	50.51
CRg		1.271	100.00	88.13	46.24	62.59
CRe		0.305	80.85	51.67	37.54	50.51
CRf		0.224	89.22	73.93	62.74	71.33
COG 1	8	1.271	0.0000	0.0017	0.1553	0.0523
Header	6	0.050	0.0002	0.0135	0.0445	0.0194
Header Edge	6	0.067	0.0007	0.0538	0.1723	0.0756
Left Jamb	7	0.062	0.0008	0.0176	0.0512	0.0232
Left Jamb Edge	7	0.086	0.0036	0.1061	0.2439	0.1178
Right Jamb	7	0.062	0.0008	0.0176	0.0512	0.0232
Right Jamb Edge	7	0.086	0.0036	0.1061	0.2439	0.1178
Sill	8	0.050	0.0034	0.0222	0.0603	0.0286
Sill Edge	8	0.067	0.0222	0.1895	0.3145	0.1754
Dewpoint (C)			2.9	10.3	15.4	

Figure 7-5. Window Library Detail View where the whole product results are calculated and displayed.

7.4.1. Individual Product SHGC and VT (SHGC 0 & 1, VT 0 & 1)

It is not necessary to calculate the SHGC and VT for all individual products and associated model sizes. *NFRC 200*- outlines a procedure for determining $SHGC_0$, $SHGC_1$, VT_0, VT_1 values which can then be used to calculate the SHGC and VT of any individual product. This procedure is used to obtain NFRC rating values.

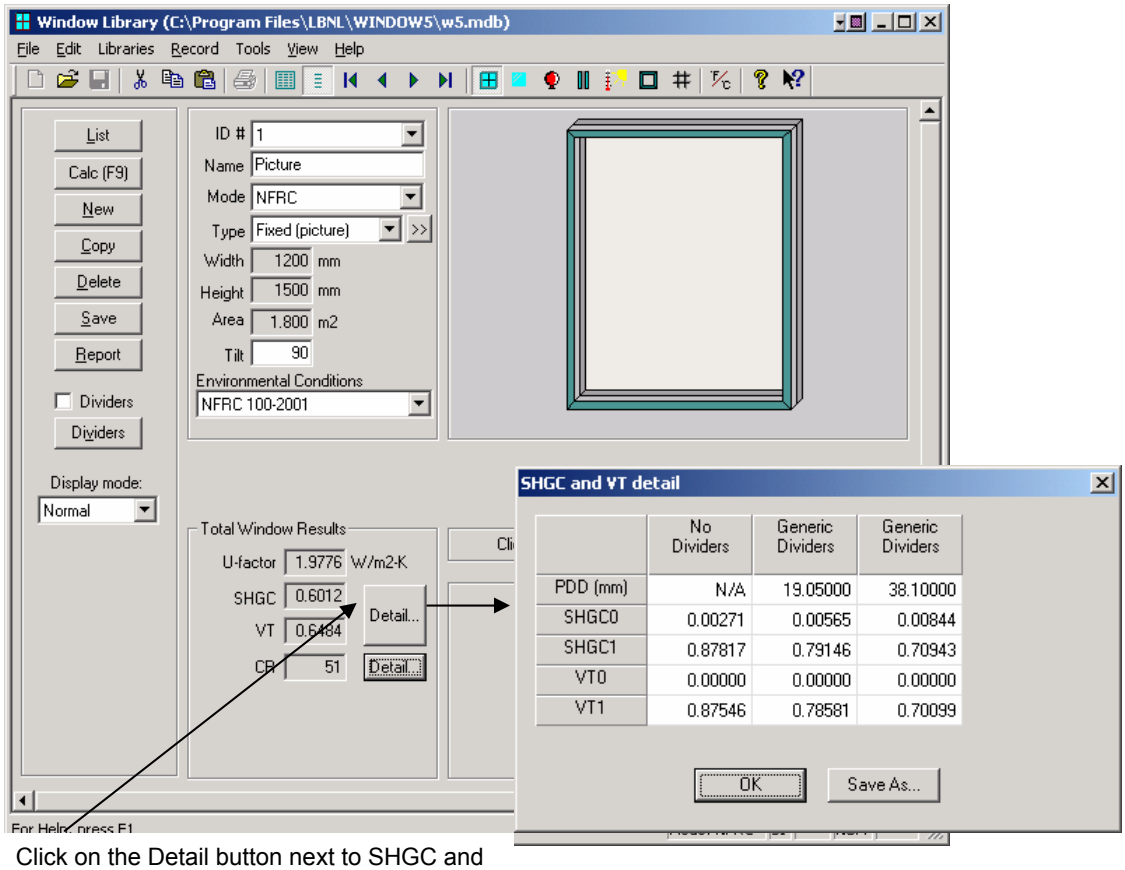
These values are calculated in WINDOW for the best glazing option modelled with the highest combined frame and edge heat loss (i.e., the option with the lowest center-of-glass –factor and the highest total product U-factor), as outlined in *NFRC 200*, Section 4.5B. The values calculated from that one case are then used to calculate the SHGC for any other glazing options using Equations 4-3 and 4-4 in *NFRC 200*.

For domed skylights (see Chapter 8 of this manual), it is necessary to use the tested value for the center-of-glass value, with the modelled frame and edge values.

The values are calculated for the product using the best glazing system, for three cases:

- No dividers
- Dividers < 25.4 mm (1″), modelled at 19 mm (0.75″)
- Dividers ≥ 25.4 mm (1″), modeled at 38 mm (1.50″)

WINDOW automatically calculates these values for all records in the Window Library, using the U-factor for the default divider as defined in NFRC 200. The values can be displayed by clicking on the Details button next to the whole product results for SHGC and VT, as shown in the figure below.



Click on the Detail button next to SHGC and VT to get the SHGC 0 &1 and VT 0 & 1 calculated for No Dividers, Dividers < 25.4 mm (1”), and Dividers ≥ 25.4 mm (1”).

Figure 7-6. Click on the Detail button to get the SHGC 0 & 1 and VT 0 & 1 results.

If the product has real dividers, the program will calculate the SHGC 0 & 1 and VT 0 & 1 values for the generic dividers as well as for the actual dividers, as shown below. For NFRC simulations, the default divider results should always be used.

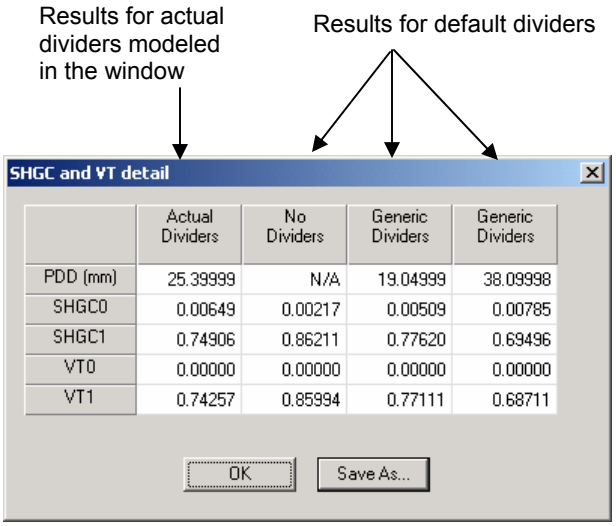
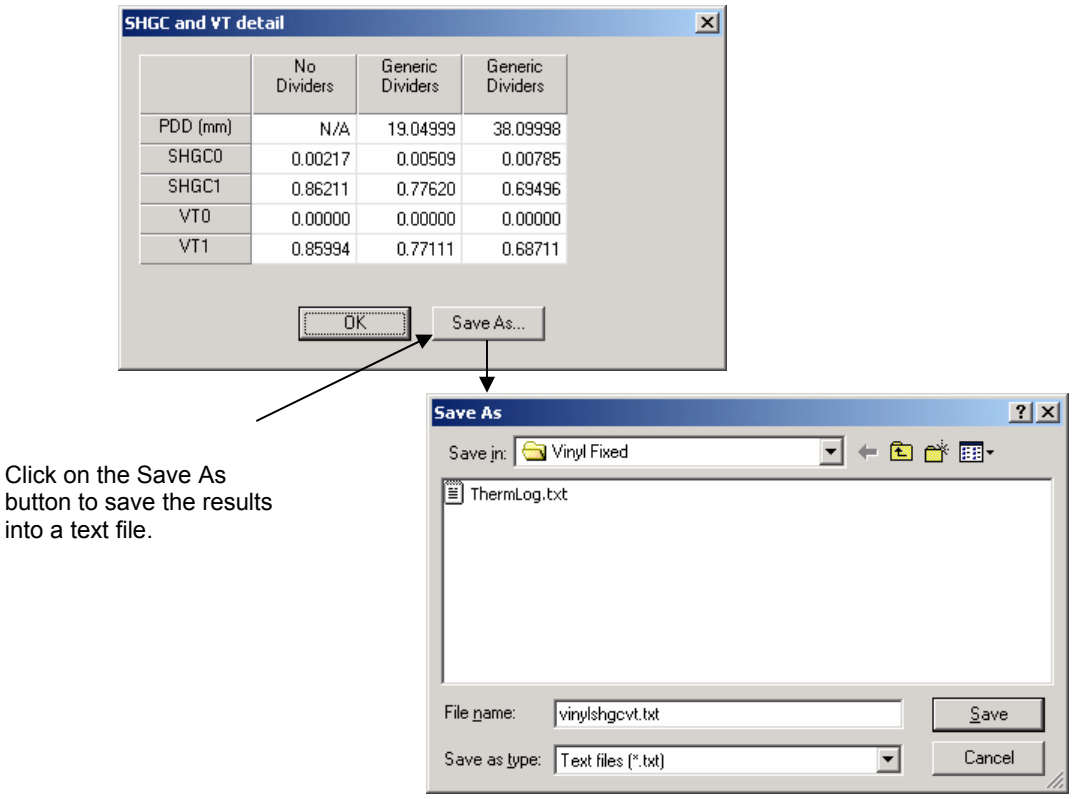


Figure 7-7. The SHGC 0 & 1 and VT 0 & 1 results are shown for the actual dividers if they are modeled.



Click on the Save As button to save the results into a text file.

The text file can be imported into other software, such as a spreadsheet.

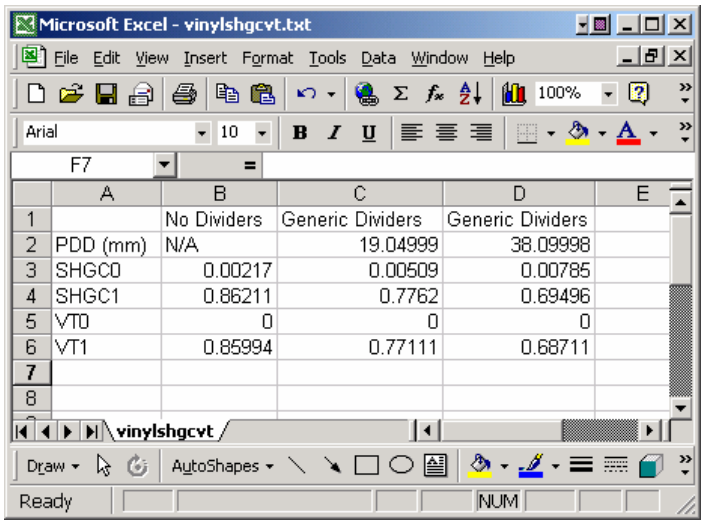


Figure 7-8. The SHGC 0 & 1 and VT 0 & 1 results can be saved to a text file which can be imported into other applications, such as a spreadsheet or word processing program.

7.4.2. Whole Product U-factor With Dividers

The generic dividers used to calculate the $SHGC_0$, $SHGC_1$, VT_0, and VT_1 values are NOT used to calculate the whole product U-factor, if the whole product is manufactured with dividers. In that case, the actual divider geometry is modeled in THERM, the THERM file is imported into the WINDOW Divider Library, and used in a record (different from those used for the $SHGC_0$, $SHGC_1$, VT_0, VT_1 calculations) in the Window Library. This is shown in the following figures.

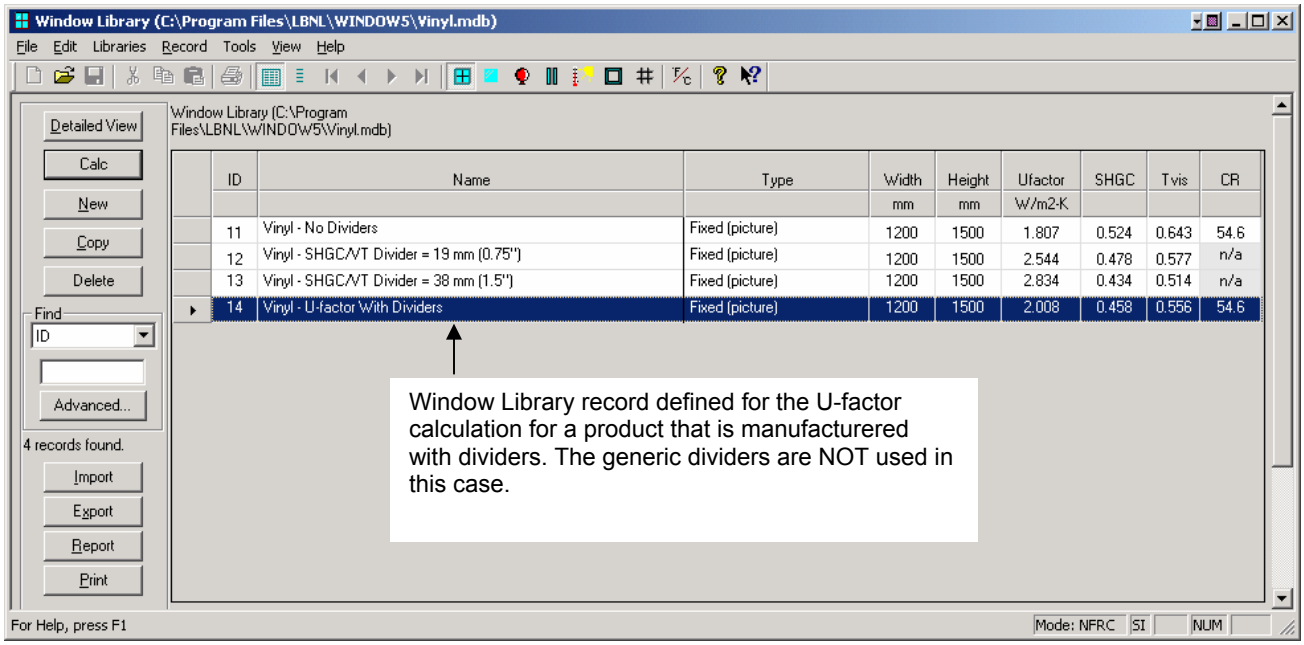


Figure 7-9. Window Library List View for the "U-factor with Dividers" case.

The Window Library Detailed View shows that the divider used for this product is from a THERM file, rather than one of the generic dividers.

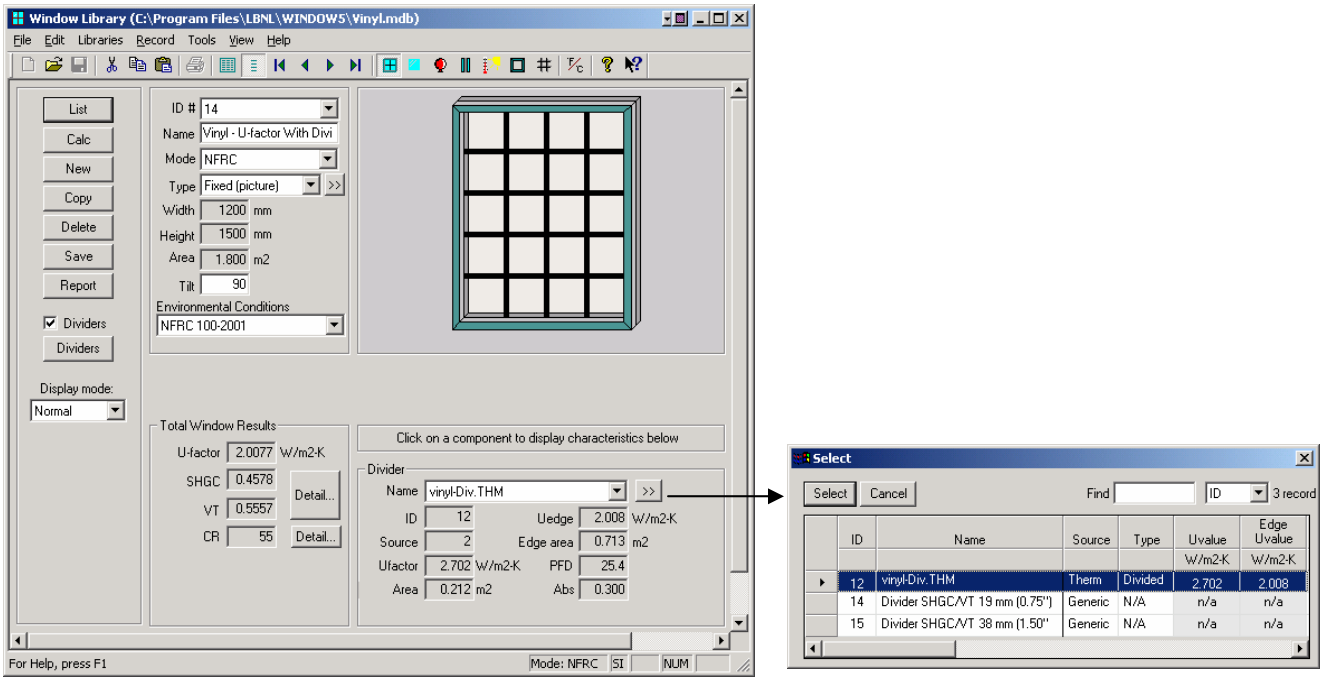


Figure 7-10. Window Library List View for the "U-factor with Dividers" case.

7.5 Project Databases

WINDOW 5 databases can be quite large. For example, the default database, w5.mdb, that is included in the program installation package, is approximately 27 MB. One of the main reasons for the large size is the records in the Glass Library – there are 1800+ records in that library as of this writing. Each entry in the Glass Library contains spectral data for that glass layer, hence the large database size. For any given modeling project, only a few of these glass layers are used.

It is possible to make a much smaller WINDOW5 project database by saving only the records in each library (particularly the Glass Library) that are used in the defined glazing systems and windows. For example, saving a project database in this fashion would mean that only the glass layers referenced by the glazing system would be saved in the Glass Library, rather than the entire Glass Library that is installed with the program. A database with only the referenced glass layers can be less than 1 MB.

Saving a smaller database in this manner is referred to in the manual as a "Project Database", meaning it contains only the needed entries for the project being modeled. In the List View of each library there is an "Export" button, which can be used to export selected records to another database. This "Export" feature is what can be used to generate a Project Database.

Many of the libraries reference other libraries for some of their values. Therefore, when a record is Exported from a library, WINDOW also has to export any other records that are referenced from the exported record. Figure 7-10 shows how each library is referenced from other libraries. The Gas, Glass, Frame, Divider and Environmental Conditions libraries are stand-alone libraries, meaning they do not reference any other libraries. However, the Glazing System and Window Libraries reference many of the other libraries.

So, for example, in order to export to another database all the information for a glazing system, WINDOW5 must also import the referenced records from the Gas Library, Glass Library and Environmental Conditions Library. But the important point is that only the needed records in each of these referenced libraries are needed in the exported database. So there might only be two or three entries in the Glass Library, i.e., those used in the Glazing System, instead of the 1800 entries that are in the entire database. This will then make the database these records are imported into much smaller.

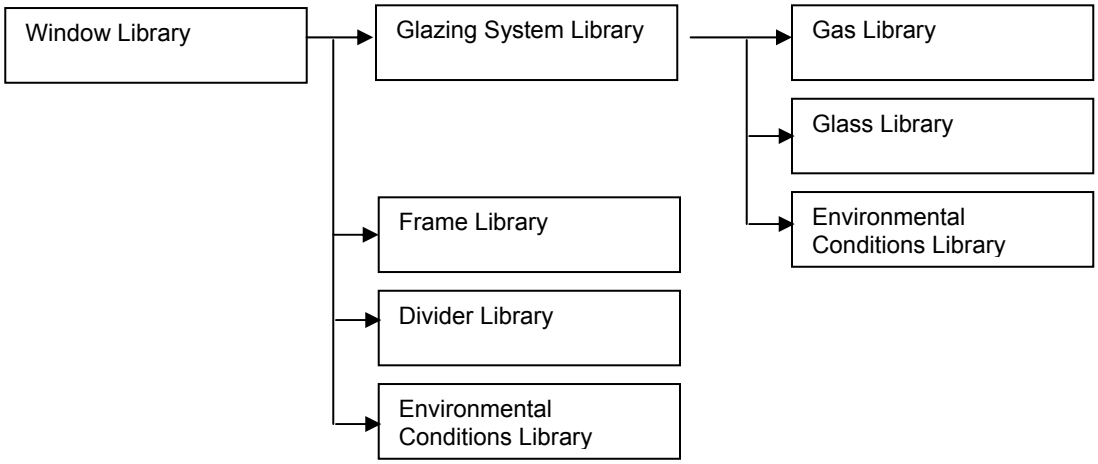


Figure 7-11. The database hierarchy in the WINDOW project database.

The steps to save a WINDOW database in this manner are the following:

- Select the Library "level" that the export should start from – in general, the most complete "level" to export from will be the Window Library.

  Start from the Window Library: this will mean that records from all the libraries that are used either directly or indirectly from those libraries will be included in the project database:

  - **Glazing System Library:** All the glazing systems referenced in the Window Library entries
  - **Frame Library:** All the frames referenced in the Window Library entries
  - **Divider Library:** All the dividers referenced in the Window Library entries, if dividers are modeled.
  - **Glass Library:** All the glass layers referenced from the glazing systems used in the Window Library entries
  - **Gas Library:** All the gases referenced from the glazing systems used in the Window Library entries
  - **Environmental Conditions Library:** All the environmental conditions referenced from the glazing systems and the Window Library entries.

  Start from the Glazing System Library: this will mean that records from the libraries used to define the glazing systems will be written into the project database, and no other entries:

  - **Glazing System Library:** All the glazing systems referenced in the Window Library entries
  - **Glass Library:** All the glass layers referenced from the glazing systems used in the Window Library entries
  - **Gas Library:** All the gases referenced from the glazing systems used in the Window Library entries
  - **Environmental Conditions Library:** All the environmental conditions referenced from the glazing systems and the Window Library entries.

Note that when you create a project database the program may display a message saying that some record already exists (based on detecting duplicate record ID numbers), and ask if you want to overwrite it, as shown below.

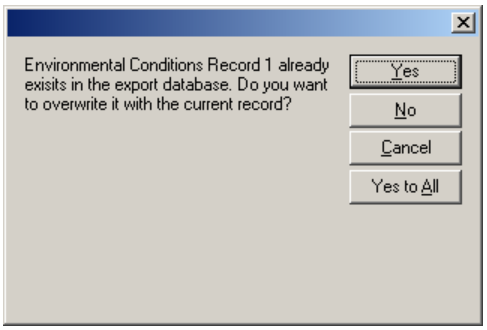


Figure 7-12. Export only referenced records into a new WINDOW5 database.

This message will always appear for a New Project Database for Record 1 of the Environmental Conditions Library, because the default "blank" database that the program writes into contains one default Environmental Conditions record. For new project databases, click the Yes button for overwriting existing records. If you are importing records into an existing database, you should determine what

record ID numbers are already defined in the existing database, and determine whether or not you should overwrite those records with records you are going to import into that database.

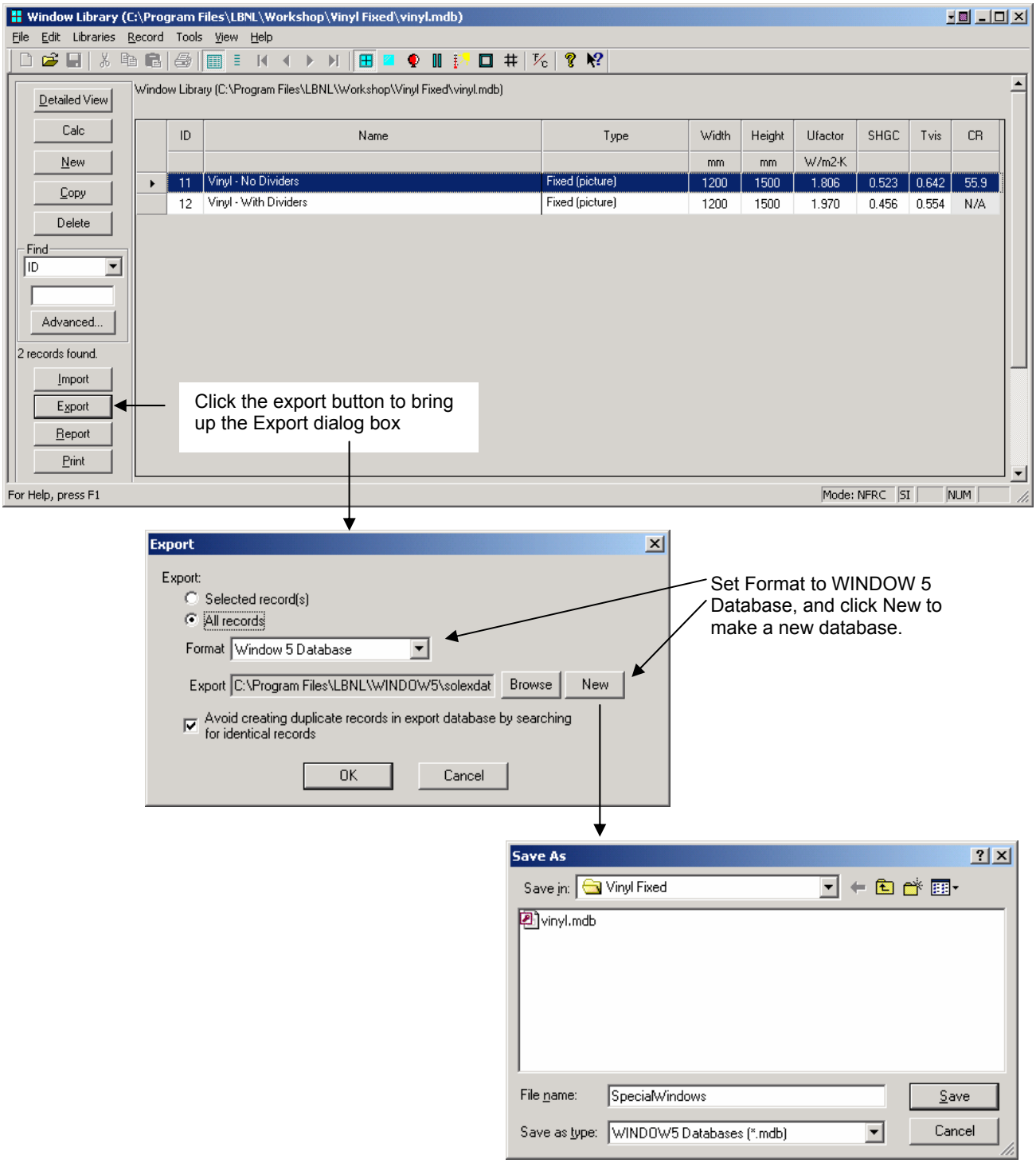


Figure 7-13. Export only referenced records into a new WINDOW5 database.